Savannah River Site
Solid Waste Management Department
Consolidated Incinerator Facility
Operator Training Program

Heating Ventilation, and Air Conditioning (U)

Study Guide

ZIOITX05

Revision 02

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Training Manager / Date

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Engineering / Date

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Facility Manager / Date

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REVISION LOG

REV.	AFFECTED SECTION(S)	SUMMARY OF CHANGE
01	All	New Issue
02	All	Updated ELOs, added information on instruments, controls, and procedures.

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REFERENCES

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2. 261-AOP-ME-01 *Exhaust System Events* Rev. 0D

3. 261-AOP-ME-02 *Makeup Air Handling Events* Rev. 0D

4. 261-SOP-CHW-01 *Chilled Water System*, Rev. 0D

5. 261-SOP-HVAC-01 *Heating Ventilation and Air Conditioning* Rev. 0D

6. 261-SOP-ME-01 *Main Exhaust* Rev. 0D

7. DA H266 , *Heating, Ventilation and Air Conditioning Functional Description* Rev. A(U)

8. Drawing W830352, *Building 261-H Ventilation Air Flow*

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13. WSRC-SA-17, *Consolidated Incineration Facility Safety Analysis Report*, DOE Approval Copy 12/95

14. ZIOISX05, *Heating, Ventilation and Air Conditioning System Design Description*, Draft A

LEARNING OBJECTIVES

TERMINAL OBJECTIVE

1.00 Without references, **EXPLAIN** the significance of the Heating, Ventilation, and Air Conditioning System to Consolidated Incinerator Facility operations, including its importance to safety, and the impact on operations of a failure of the system.

ENABLING LEARNING OBJECTIVES

1.01 **STATE** the purpose of the Heating, Ventilation, and Air Conditioning System.

1.02 Briefly **DESCRIBE** how the Heating, Ventilation, and Air Conditioning System accomplishes its intended purpose.

1.03 **EXPLAIN** the consequences of a failure of the Heating, Ventilation, and Air Conditioning System to fulfill its intended purpose, including the effects on other systems or components, overall plant operation, and safety.

TERMINAL OBJECTIVE

2.00 Using system diagrams, **EVALUATE** potential problems which could interfere with normal Heating, Ventilation, and Air Conditioning System flow paths to determine their significance on overall system operation and the corrective actions needed to return the system to normal.

ENABLING LEARNING OBJECTIVES

2.01 **DESCRIBE** the Chilled Water System arrangement to include a drawing showing the following system components and interfaces with other systems:

a. Chiller Unit
b. Chilled Water Pumps
c. Expansion Tank
d. Air Handling System
e. Service Water System

2.02 **DESCRIBE** the Air Handling System arrangement to include a drawing showing the following system components and interfaces with other systems:

a. Inlet Damper
b. Pre-Heat Coils
c. Cooling Coils
d. Air Handling Fan
e. Steam System
f. Instrument Air System

2.03 **DESCRIBE** the Main Exhaust System arrangement to include a drawing showing the following system components and interfaces with other systems:

a. Main Exhaust Fans
b. Isolation Dampers
c. Inlet Vane Dampers
d. HEPA Filters
e. Air Handling System
f. Instrument Air System
g. Rotary Kiln Shaft Seals
h. Air Monitoring System

2.04 **DESCRIBE** the Control Room HVAC System arrangement to include a drawing showing the following system components and interfaces with other systems:

a. Chiller Unit
b. EER Ventilation Fan
c. Toilet Exhaust Fan
d. Service Water System

TERMINAL OBJECTIVE

3.00 Given values of Heating, Ventilation, and Air Conditioning System operation parameters, **EVALUATE** potential problems that could effect the normal functioning of the system or its components to determine the significance of the existing condition and the actions required to return the system to normal operation.

ENABLING LEARNING OBJECTIVES

3.01 **DESCRIBE** the following major components of the Heating, Ventilation, and Air Conditioning System to include their functions, principles of operation, and basic construction:

a. Chiller
b. Chilled water pumps
c. Chilled water expansion tank
d. System dampers
e. System HEPA filters
f. Main exhaust fans

3.02 **DESCRIBE** the following Heating, Ventilation, and Air Conditioning System instrumentation including indicator location (local or Control Room), sensing points, and associated instrument controls:

a. HEPA Filter differential pressure
b. Main Exhaust Flow
c. HEPA Filter inlet pressure
d. Area Differential Pressure

3.03 **EXPLAIN** how the following Heating, Ventilation, and Air Conditioning System equipment is controlled in all operating modes or conditions to include control locations (local or Control Room), basic operating principles of control devices, and the effects of each control on the component operation:

a. Main Exhaust Fan
b. Main Exhaust Fan Inlet Vane Damper
c. Main Exhaust Fan Outlet Damper
d. Air Handling Fan
e. Air Handling Unit Inlet Damper

3.04 **DESCRIBE** the interlocks associated with the following Heating, Ventilation, and Air Conditioning System equipment to include the interlock actuating conditions, effects of interlock actuation, and the reason the interlock is necessary:

a. Main Exhaust Fan

b. Air Handling Fan

c. Control Room HVAC

d. Toilet Exhaust Fan

3.05 **INTERPRET** the following Heating, Ventilation, and Air Conditioning System alarms, including the conditions causing alarm actuation and the basis for the alarms:

a. HEPA Filter differential pressure

b. Main Exhaust Flow

c. Chiller Failure

TERMINAL OBJECTIVE

4.00 Given necessary procedures or other technical documents and system conditions, **DETERMINE** the operator actions required for normal and abnormal operation of the Heating, Ventilation, and Air Conditioning System including problem recognition and resolution.

ENABLING LEARNING OBJECTIVES

4.01 **STATE** the personnel safety concerns associated with the Heating, Ventilation, and Air Conditioning System.

4.02 Given applicable procedures and plant conditions, **DETERMINE** the actions necessary to perform the following Heating, Ventilation, and Air Conditioning System operations:

a. Startup
b. Manual Operation of Equipment
c. Shutdown

4.03 **DETERMINE** the effects on the Heating, Ventilation, and Air Conditioning System and the integrated plant response when given any of the following:

a. Indications/alarms
b. Malfunctions/failure of components
c. Operator Actions

SYSTEM PURPOSE

Purpose

ELO 1.01	**STATE** the purpose of the Heating, Ventilation, and Air Conditioning System.
ELO 1.02	Briefly **DESCRIBE** how the Heating, Ventilation, and Air Conditioning System accomplishes its intended purpose.
ELO 1.03	**EXPLAIN** the consequences of a failure of the Heating, Ventilation, and Air Conditioning System to fulfill its intended purpose, including the effects on other systems or components, overall plant operation, and safety.

The Heating, Ventilation and Air Conditioning (HVAC) System is designed to protect the public, the environment, and on-site operating personnel by confining radioactive and other hazardous airborne materials to the system boundaries and the High Efficiency Particulate Air (HEPA) filters. This objective is achieved by maintaining the enclosures at a negative pressure with respect to the atmosphere, while ensuring that all potentially contaminated building exhausts are filtered and monitored prior to atmosphere releases.

The HVAC System provides conditioned air to the Ashout, Kiln Feed, and Box Handling Areas. The air is exhausted through a HEPA filter train and discharged through the facility stack using redundant centrifugal fans. This air combines with the Offgas exhaust in the CIF stack and provides additional cooling to the flow. This cooling prevents damage to and extends the life of the fiberglass stack. Without the cooling of the HVAC air, the temperature entering the stack would exceed 220 °F and weaken the fiberglass.

The Control Room HVAC System is a separate self-contained system that supplies the Instrument Control Room (ICR), the Instrument Equipment Room (IER), offices and restroom with a slightly positive pressure with respect to rest of the facility. The Electrical Equipment Room (EER) is ventilated using a wall fan.

The first three of the Heating, Ventilation, and Air Conditioning subsystems are combined to effectively confine the airborne material to the Ashout, Kiln Feed and Box Handling Areas. This is achieved by maintaining the areas at a negative pressure with respect to atmospheric pressure. The Control Room HVAC unit and associated ducting is designed to provide positive pressure in the Instrument Control Room and Instrument Equipment Room.

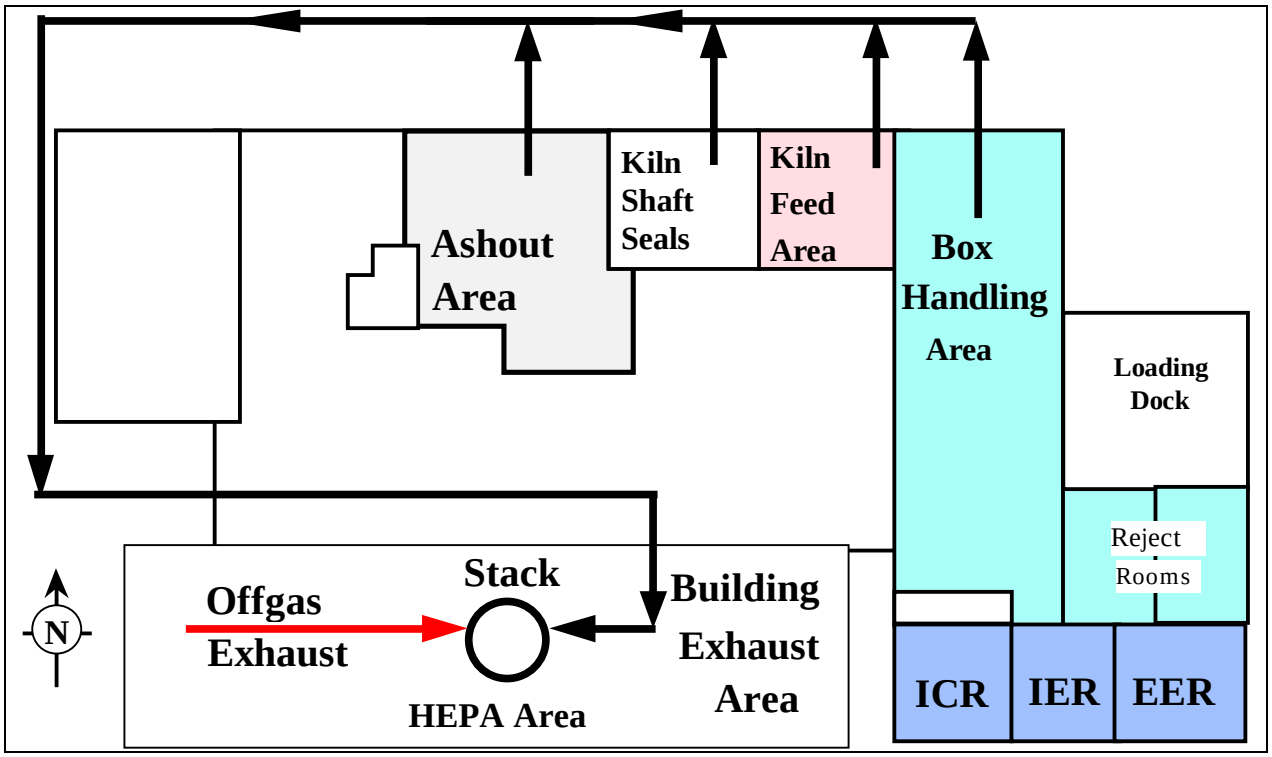

Figure 1 Areas Exhausting to the CIF Stack

The Air Handling System is designed to provide conditioned air to the Ashout, Kiln Feed and Box Handling Areas. The air is conditioned by the Chilled Water (CHW) System and moved through the duct work to the appropriate areas. The Main Exhaust (ME) System pulls the air from the designated areas and then filters the air though the HEPA filters. The air is then exhausted to the atmosphere via the main stack. This exhaust air provides cooling to the air in the exhaust stack and prevents damage to the fiberglass structure of the stack. A negative pressure is achieved by pulling more air from the areas than is supplied by the Air Handling System.

In addition to the containment of airborne material, the HVAC System maintains the areas within Building 261-H at regulated temperatures for the protection of equipment and the comfort of personnel. This is important in the Kiln Feed Area where temperatures would exceed 100 °F and overheat electrical components.

Summary

The purpose of the CIF HVAC System is to:

- Provide cooling to the air in the exhaust stack and prevents damage to the fiberglass structure of the stack.
- Confine airborne material from the Ashout, Kiln Feed and Box Handling Areas and the kiln seal shroud and filter it through HEPA filters.
- Provide conditioned air to for the protection of equipment and the comfort of personnel.

The CIF HVAC System accomplishes this purpose by:

- The HVAC System utilizes controlled air flow to maintain a slight vacuum on the Box Handling , Kiln Feed , and the Ashcrete Areas.
- A vacuum is also maintained on the kiln seal shroud to control air flow escaping through the seals to atmosphere.
- The public, the environment, and on-site operating personnel are protected by confining radioactive and other hazardous airborne materials to the system boundaries.

DESCRIPTION AND FLOWPATH

ELO 2.01	**DESCRIBE** the Chilled Water System arrangement to include a drawing showing the following system components and interfaces with other systems: a. Chiller Unit b. Chilled Water Pumps c. Expansion Tank d. Air Handling System e. Service Water System f. Chilled Water System

Chilled Water System

The Chilled Water System is a closed loop system consisting of a chiller, cooling coils, circulation pumps and other necessary equipment such as valves and piping (Figure 2). Water is circulated through the chiller unit, to the air handling cooling coils, through pumps, and back to the chiller unit. The chiller unit is a refrigeration unit that removes heat from the water circulating through the cooling loop. Two water pumps are available to circulate the chilled water with one pump normally in operation and the other in stand-by. Make up water is supplied from the Service Water System.

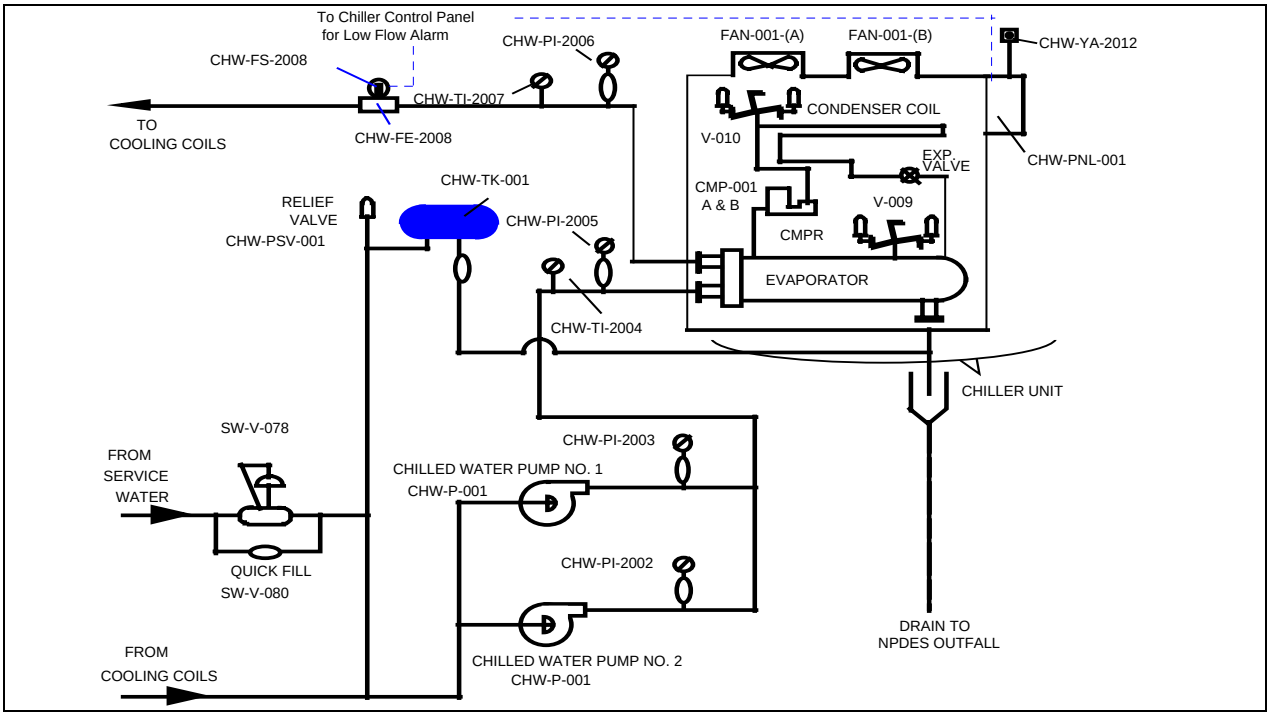

Figure 2 Chilled Water System

The water supplied for the cooling coils is controlled by a three-way air-operated valve (H-261-CHW-TCV-5116, Figure 3), which is controlled to regulated the outlet air temperature of the air handling unit. With no air supplied to the valve, water will recirculate back to the Chilled Water System without passing through the coils. As the air signal controls the valve to open, water is allowed to flow though the air handling unit cooling coils.

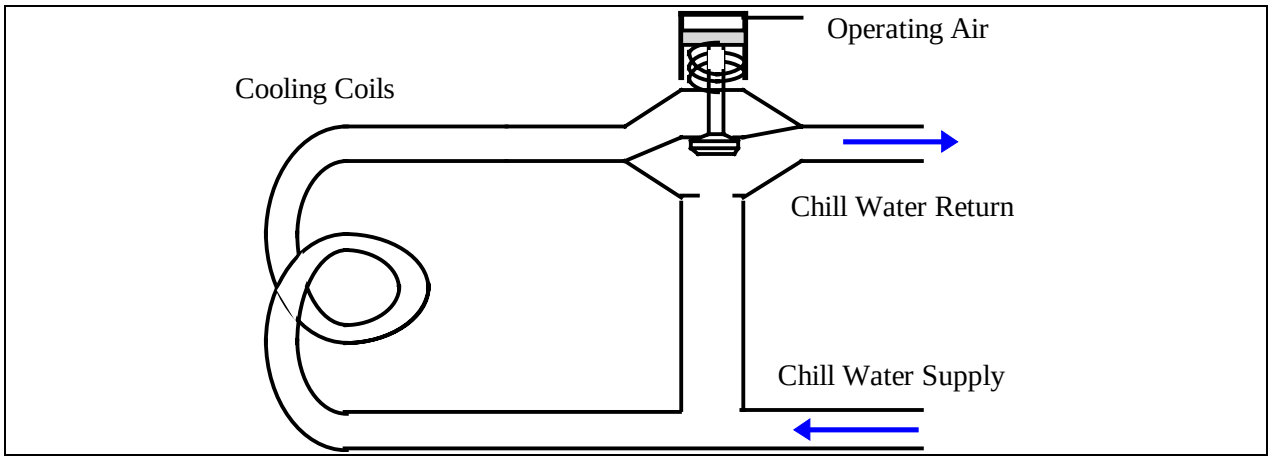

Figure 3 Three-Way Air-Operated Valve

ELO 2.02	**DESCRIBE** the Air Handling System arrangement to include a drawing showing the following system components and interfaces with other systems: a. Inlet Damper b. Pre-Heat Coils c. Cooling Coils d. Air Handling Fan e. Steam System f. Instrument Air System

Air Handling System

The Air Handling System is comprised of a supply fan, an outside air filter, an air handling unit and associated duct work. The air handling unit consists of a steam heating coil that is supplied with 30 psig steam from the low-pressure steam header and two cooling coils that are supplied with chilled water from the Chilled Water System. The air flow begins outside the air handling unit. The fan pulls air in through the intake damper, through the outside air filter, past the heating and cooling coils, then to the fan. The fan pushes the conditioned air through the duct work to the designated areas. (See Figure 4, *Air Handling System.*)

The steam that supplies the heating coil of the air handler is also routed through five (5) unit heaters located in the Box Handling Area. Any additional heat demand in the Box Handling Area will be satisfied by these five unit heaters. The heaters are energized by their respective thermostats.

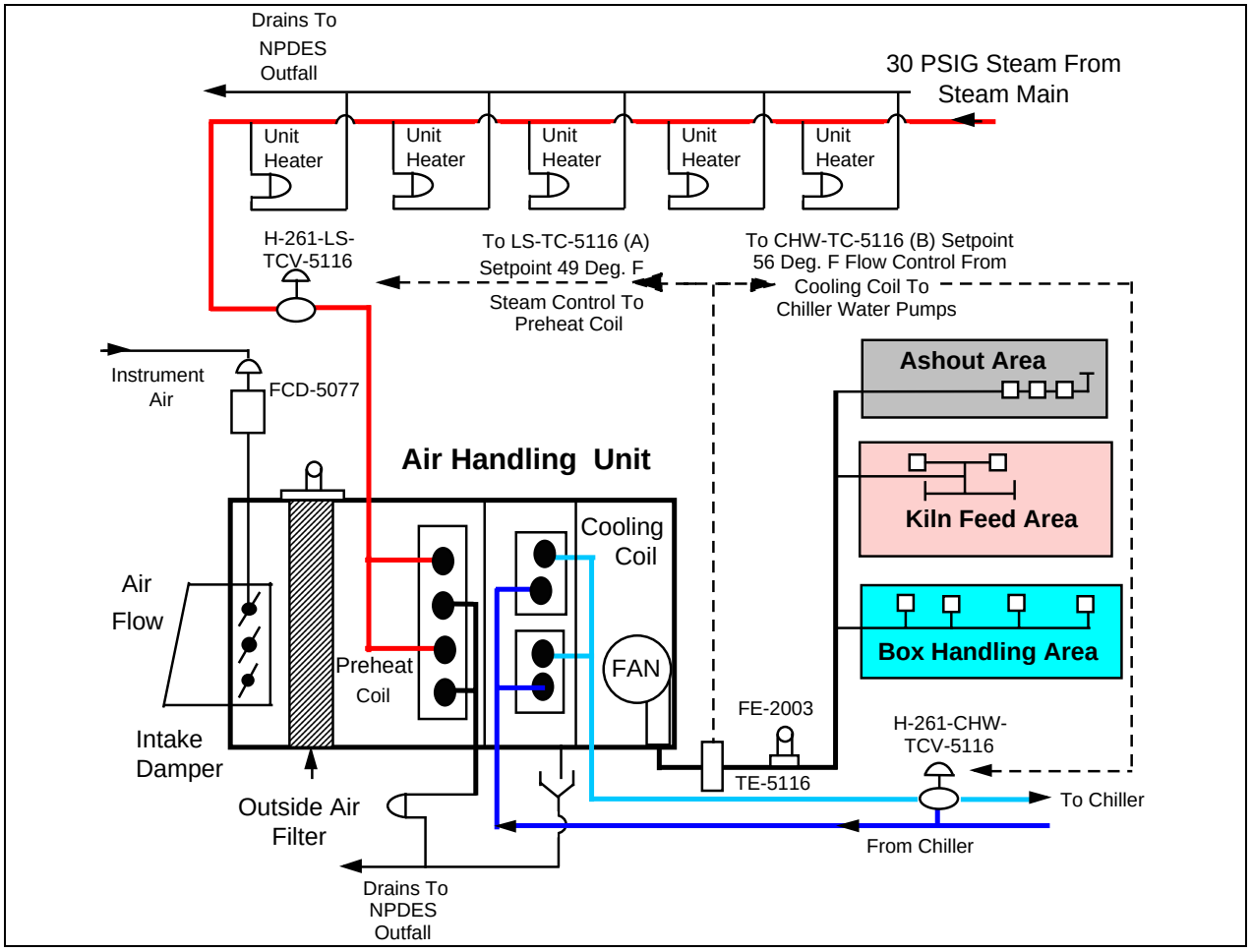

Figure 4 Air Handling System

ELO 2.03	**DESCRIBE** the Main Exhaust System arrangement to include a drawing showing the following system components and interfaces with other systems: a. Main Exhaust Fans b. Isolation Dampers c. Inlet Vane Dampers d. HEPA Filters e. Air Handling System f. Instrument Air System g. Rotary Kiln Seal Shroud h. Air Monitoring System

Main Exhaust System

The Main Exhaust System removes air from the three (3) designated areas as well as from the kiln seal shroud. Air is pulled from these enclosures and the kiln seal shroud through the HEPA filters by the exhaust fan. The air is then discharged to the facility stack. The air from the kiln seal shroud is filtered through a HEPA filter prior to entering the main duct work of the Main Exhaust System. The HEPA filter housings and two (2) exhaust fans are provided on the main duct work, but only two (2) filter housings and one (1) fan are normally in service. The main Exhaust System completes the combined HVAC system for the designated enclosures. (See Figure 5, *Main Exhaust System.*)

In addition to the kiln shroud, the Main Exhaust System pulls air from three areas:

- Box Handling Area
- Ram Feed Area
- Ashout Area

Air pulled from the Ashout Area originates from two locations: 1) the general room area and 2) the Ash Processsing Unit (APU). The air from the APU is discharged using a fan on the APU enclosure. Air is routed from this fan into the main exhaust ductwork.

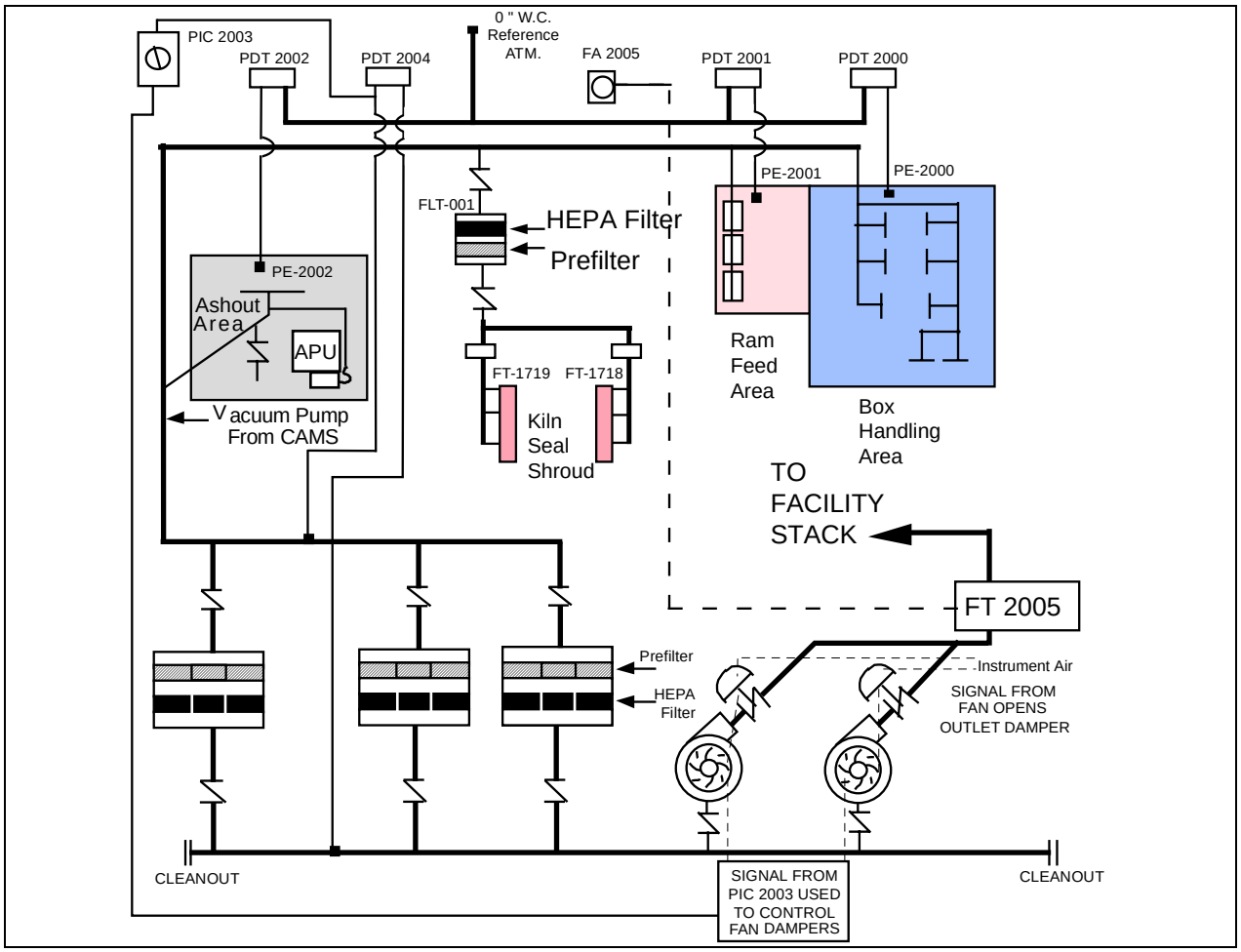

Figure 5 Main Exhaust System

ELO 2.04	**DESCRIBE** the Control Room HVAC System arrangement to include a drawing showing the following system components and interfaces with other systems: a. Chiller Unit b. EER Ventilation Fan c. Toilet Exhaust Fan d. Service Water System

Control Room HVAC System

The Control Room HVAC System is a separate self-contained system. This system provides conditioned air, at a slightly positive pressure with respect to the facility, to the ICR, the IER, offices and the rest rooms. The positive pressure prevents contamination due to infiltration from the facility by "blowing" air out of the affected areas. The EER is ventilated using an axial fan/louver arrangement, but does not receive conditioned air. The flowpath of the Control Room HVAC System can be seen in Figure 6, *Control Room HVAC*.

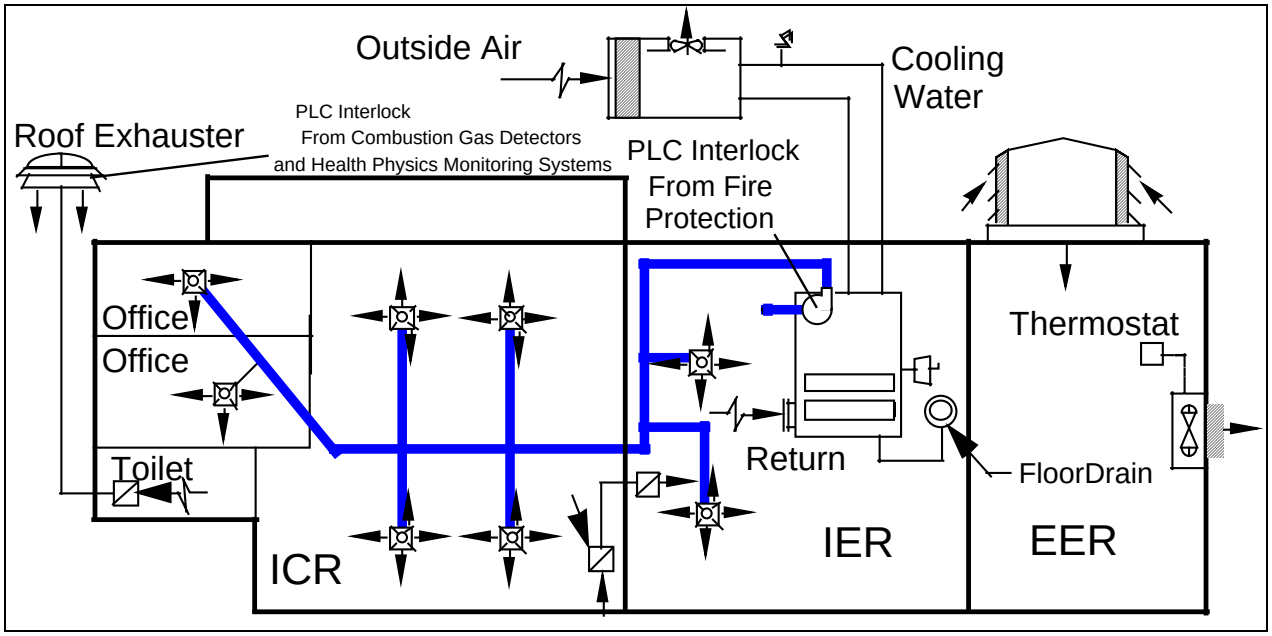

Figure 6 Control Room HVAC

Summary

The CIF HVAC system is comprised of a Chilled Water System, an Air Handling System, and a Main Exhaust System. A separate stand-alone HVAC unit is provided for environment control of the Control Room .

MAJOR COMPONENTS

ELO 3.01	**DESCRIBE** the following major components of the Heating, Ventilation, and Air Conditioning System to include their functions, principles of operation, and basic construction: a. Chiller b. Chilled water pumps c. Chilled water expansion tank d. System dampers e. System HEPA filters f. Main exhaust fans

Chilled Water System

The Chilled Water System is provided to supply chilled water to the cooling coils of the air handler. This system utilizes a refrigeration system along with a closed-loop chilled water circulation line to achieve its purpose. The system is comprised of a reciprocating chiller, two chilled water pumps, an expansion tank, an air operated flow control valve to control temperature, associated piping and instrumentation.

Reciprocating Chiller

The purpose of the chiller is to provide chilled water to the Air Handling System. The chiller is comprised of a motor compressor, an evaporator, condenser coils, condenser fans and motors, a refrigerant circuit and a microprocessor control center. The Chiller Unit is powered from MCC 6.

Chilled Water Pumps

Two water pumps (CHW-P-001 & 002) are supplied to enhance reliability and to ensure availability when one pump is down for service. The pumps are rated at 180 gpm @ 100 ft total discharge head and provide circulation capability of the chilled water. The chilled water pumps are powered from MCC 6.

Expansion Tank

The Chilled Water System is equipped with an expansion tank (CHW-TK-001). This tank is necessary to provide for an expansion reservoir for temperature changes. As an additional function, it acts to also maintain an appropriate amount of suction head for the chilled water pumps. The expansion tank is equipped with a sight glass for level indication, and a drain line for maintenance purposes.

Normal fill of the Chilled Water System is from the Service Water System using a manual fill valve (SW-V-080). In a line parallel to the manual fill valve, there is a pressure regulating valve (SW-V-078). This pressure regulating valve was designed into the system to automatically maintain the Chilled Water System water inventory. If water leaked out of the system, the expansion tank level would go lower, and the static pressure supplied by the water level would decrease. A pressure loss would be sensed by the pressure regulating valve, which would open to recharge the Chilled Water System. Because the regulating valve is not fully reliable, the normal fill is though SW-V-080.

Air Handling System

The Air Handling System is comprised of a self-contained air handling unit and associated duct work. The air handling unit consists of an inlet damper, an outside air filter, a steam preheat coil, two chilled water cooling coils in parallel, and a supply fan.

Inlet Damper

The inlet damper (H-261-HVAC-FCD-5077) is a louver arrangement controlled by a common metal operating rod. The operation of the louvers is similar to that of a window shutter. The common operating rod is driven by an air operated piston, which receives twenty (20) psig instrument air controlled by a flow control valve (H-261-FY-5077). This valve is a solenoid valve which receives signaling to open the damper from the motor control circuitry of the Air Handling Fan.

Outside Air Filter

The air filters are throwaway fiberglass mat filters and are arranged in a "Z" angle rack configuration. These filters provide filtration before the air is moved to the supplied areas.

Steam Preheat Coil

The steam coil (H-261-HVAC-COIL-001) is a double tube coil with a capacity of 327,000 BTU/hr at a steam flow rate of 350 lb./hr @ 30 psig. The steam coils are fed from the 30 psig low-pressure steam header and provide heating capability for the air. The flow through the preheat coil is controlled by an air operated valve (H-261-HVAC-TCV-5116).

Chilled Water Cooling Coil

The chilled water cooling coil (H-261-HVAC-COIL-002) is actually two identical coils in parallel. The coils are copper tubing with a cooling capacity of 925,000 Btu/hr at a water flow rate of 180 gpm. The cooling coils are fed by the Chilled Water System and provide cooling capability for the air. Each individual coil can be separately valved out from the Chilled Water System, allowing for half the cooling capacity in the event of a coil leak. The water flow rate through the cooling coils is regulated by a three-way air-operated valve (H-261-CHW-TV-5116-(B)).

Air Handling Fan

The supply fan for the HVAC System (H-261-HVAC-FAN-001) is a centrifugal type fan and is capable of producing 10,250 cfm of airflow at a static pressure of 3.0 INWC. This fan provides the energy input necessary to move the air to the supplied areas. The fan is powered from MCC 6.

Duct work

The duct work of the Air Handling System allows the transfer of conditioned air from the air handling unit to the designated areas. There is no return air to the air handling unit.

Main Exhaust System

The Main Exhaust System provides the means of moving and filtering air from the Ashout, Kiln Feed and Box Handling Areas. Also, an induced draft is pulled on the kiln seal shroud by this system. The system is comprised of four (4) HEPA filter housings, two (2) exhaust fans, dampers and associated duct work.

HEPA Filters

Three (3) of the four HEPA filter housings are installed in parallel. These three units (H-261-ME-FLT-002, 003, & 004) contain nine (9) pre-filters and nine (9) filter elements. Only two of these three units will normally be in operation. These filters are necessary to remove hazardous particulates from the air exhausted from the affected areas and to provide a second filtration of the exhaust air from the kiln seal shroud.

The forth HEPA filter (H-261-ME-FLT-001) is installed prior to the Main Exhaust System main duct tap-in providing a pre-filter of the kiln seal shroud draft. This unit contains only one (1) pre-filter and one (1) filter element. This filter arrangement is necessary to allow for a pre-filtration of the exhaust from the kiln seal shroud.

Main Exhaust Fans

Two (2) exhaust fans (H-261-ME-FAN-001 & 002) are installed in parallel downstream of the main HEPA filters. These fans are rated at 20,000 cfm @ 12.0 INWC static pressure. Only one fan is normally in operation while the other fan is in standby mode. These fans provide the energy input necessary to move the exhaust air from the process areas and the kiln seal shroud to the atmosphere via the facility stack. Each fan has an integral inlet vane damper which is air operated from instrument air at eighty (80) psig. These dampers iris open and closed like a camera shutter to throttle flow though the fan. The control for the 80 psig instrument air is provided in turn from a twenty (20) psig air signal from the pressure controller (H-261-ME-PIC-2003). For simplicity of control, the controller (ME-PIC-2003) operates both inlet vanes at the same time. The fans are powered from MCC 7 and 8.

Dampers

Dampers are installed to regulate air flow and to allow the changing of filters. Control dampers at the outlet of the exhaust fans (H-261-ME-FCD-2009 & 2010) prevent flow through the idle fan. The control dampers are provided with instrument air for motive force.

Duct work

The duct work of the Main Exhaust System allows the transfer and filtration of exhaust air from the designated areas to the facility stack.

Control Room HVAC

The Control Room HVAC unit is a self-contained split unit used to provide heating and cooling to the ICR, the IER, offices and restroom. These areas are provided with conditioned air at a slightly positive pressure with respect to the facility. This positive pressure assures no infiltration of hazardous airborne material from the facility. This unit also allows for the control of humidity in the affected areas. A roof exhaust fan is also provided for the restroom of the control building.

The cooling portion of the unit relied on a roof mounted chiller unit for refrigeration. The chiller cools water which is circulated through coils in the ducting of the main portion of the unit. For heating, the Control Room HVAC unit utilizes electric heater coils.

INSTRUMENTATION

ELO 3.02	**DESCRIBE** the following Heating, Ventilation, and Air Conditioning System instrumentation including indicator location (local or Control Room), sensing points, and associated instrument controls: a. HEPA Filter differential pressure b. Main Exhaust Flow c. HEPA Filter inlet pressure d. Area Differential Pressure

Chilled Water System

The Chilled Water System is equipped with flow switches, pressure gauges and temperature gauges for detecting and measuring flow, pressure and temperature. The control panel of the Chilled Water System provides an alarm to the HVAC Control Panel if the Chilled Water System fails.

Pressure Gauges

Several pressure gauges are installed in the Chilled Water System to monitor system operation. They are located at the outlet of the chilled water pumps (H-261-CHW-PI-2003 & 2002), at the inlet of the evaporator (H-261-CHW-PI-2005), and at the outlet of the evaporator (H-261-CHW-PI-2006).

Temperature Gauges

Temperature Indication Two (2) temperature gauges are installed in the chilled water flow path (H-261-TI-2004 & 2007). These gauges are located in thermowells in the Chilled Water System piping at the inlet and outlet of the chiller unit evaporator. The temperature instrument should not be confused with the thermowell on a P&ID. A thermowell is a penetration in a pipe or other container where a temperature element may be inserted. Thermowells in the Chilled Water System allow for the temperature elements to be inserted into the flow stream without physically breaking the piping boundaries. There are several thermowells in the Chilled Water System , but only two are provided with temperature indication. The temperature elements are located across the evaporator because a difference in temperature indicates heat transfer, therefore the operation of the evaporator can be measured.

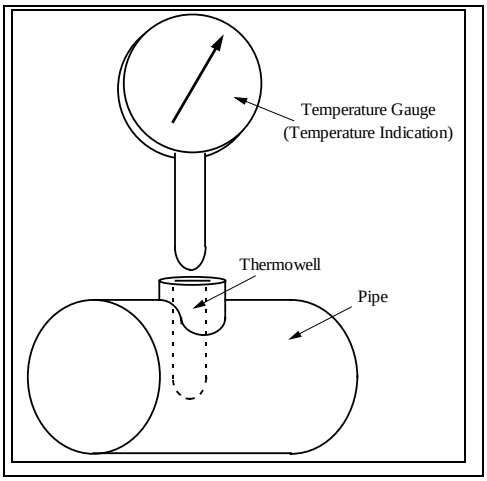

Figure 7 Thermowell vs. Temperature Indication

Low Flow Switch

Chilled water flow from the outlet of the evaporator passes through a flow element (H-261-CHW-FE-2008) which inputs a signal to the Low Flow Switch (H-261-CHW-FSL-2008). The low flow switch closes at a flow rate of fifty (50) gallons per minute and decreasing. When this switch closes, the chiller unit is signaled to shut down, and the stand-by chilled water pump is automatically started by motor control relays.

Air Handling System

The Air Handling System is equipped with temperature sensors, temperature controllers, temperature indication, and flow sensors.

Temperature Instruments

The temperature instruments work together to maintain a supply of conditioned air to the enclosures. The temperature sensor (H-261-HVAC-TE-5116) measures the air temperature exiting the Air Handling unit. The controllers (H-261-HVAC-TC-5116-(A)) and (H-261-CHW-TC-5116-(B)) regulate the cooling or heating applied to the air flowing through the Air Handling unit for conditioning needs. If the air exiting the unit is too hot, more cooling water is supplied to the coils to cool the air passing around the coils. If the air is too cold, stem is allowed to flow though the preheat coil and the air becomes heated. A dial type indication (H-261-HVAC-TI-5116) is located on the front of the HVAC control Panel for monitoring of system performance.

Differential Pressure Detectors/Flow Sensors

The flow sensor (H-261-HVAC-FE-2003) is a differential pressure detector which measures the air flow of the Air Handling System at the outlet of the Air Handling unit. This instrument displays flow in units of Standard Cubic Feet per Minute (SCFM). It is a local indication only. The differential detector (H-261-HVAC-PDI-2001) is also a local indication which displays the differential pressure across the Inlet filter. This detector indicates in units of inches of water column (INWC). A high differential pressure across the filters would indicate possible clogging and the need to replace the filters.

Main Exhaust System

The Main Exhaust System is equipped with pressure sensors and flow sensors. Automatic inlet vane dampers on the Main Exhaust fans are used for flow control of the air. By measuring the vacuum at the inlet to the HEPA filters, the system can regulate total air flow through the system. Performance of the system can be measured by observing the process area differential pressures and HEPA filter differential pressure.

Pressure Sensors

The pressure sensors associated with the process area differential pressure use a common pressure detector (H-261-ME-PE-2000-(A)) which measures the atmospheric pressure. This detector is located near the top of the CIF Stack to avoid drafting effects around the building. The area detectors (H-261-ME-PE-2000), (H-261-ME-PE-2001), and (H-261-ME-PE-2002) measure the pressures in the Box Handling Area, the Kiln Feed Area, and the Ashcrete Areas respectively. Differential pressure transmitters (H-261-ME-PDT-2000), (H-261-ME-PDT-2001), and (H-261-ME-PDT-2002) compare each area pressure signal to the common atmospheric signal and develop the differential pressure signals. The differential pressure transmitters display the area differential pressure as a digital indication of detector scale, displayed on the HVAC Control Panel. In order to read the signal, the detector scale must be determined using the setpoint index, and then converted from percent scale to differential pressure.

Example

Area differential pressures are 0.04, 0.05, and 0.3 INWC for the Box Handling Area, the Kiln Feed Area, and the Ashcrete Area respectively. What would the digital display read for each?

The differential pressure transmitters have the following ranges:

- ME-PDT-2000 : range = 0.0-0.1 INWC
- ME-PDT-2001 : range = 0.0-0.1 INWC
- ME-PDT-2002 : range = 0.0-0.5 INWC

Using the equation:

$$\frac{\text{Display indication}}{100\ \%} = \frac{\text{Area pressure}}{\text{Max. range of detector}}$$

we can substitute values to see that the digital display will indicate:

$$\frac{\text{Display indication}}{100\ \%} = \frac{\text{0.04 INWC in Box Handling Area}}{\text{0.1 INWC}}$$

Display indication = 40.0 for Box Handling Area

$$\frac{\text{Display indication}}{100\ \%} = \frac{\text{0.04 INWC in Kiln Feed Area}}{\text{0.1 INWC}}$$

Display indication = 50.0 for Box Handling Area

$$\frac{\text{Display indication}}{100\ \%} = \frac{\text{0.3 INWC in Ashcrete Area}}{\text{0.5 INWC}}$$

Display indication = 80.0 for Ashcrete Area

The differential pressure detector for the HEPA filter operates in much the same way as the area differential pressure detectors. The transmitter for the filters has a detector element at the inlet and outlet ducting of the filters. The range for the transmitter is 0-10.0 INWC, and it also has a digital display on the HVAC Control Panel.

The pressure signal from the inlet to the HEPA filters is also used by controller (H-261-ME-PIC-2003). This controller regulates air flow through the system and from the areas by maintaining the inlet vacuum of the HEPA filters at 4.5 INWC vacuum. It does this through a feedback loop by controlling the inlet vane dampers of the Main Exhaust fans. If the vacuum at the inlet of the filter lowers (indicating less flow), then the inlet vanes open and more air is pulled by the operating fan. More air flow causes a greater vacuum at the filter inlet and the vacuum is returned to 4.5 INWC. The operation of the inlet dampers will therefore be controlled by the vacuum sensed at the HEPA filter inlet.

Flow Sensors

There are two flow sensors associated with the Main Exhaust System. The first sensor (H-261-ME-FT-2005)is a venturi type detector. This detector measures flow by differing the cross sectional area of the duct and comparing the differential pressure caused by air flow though the changing area. This detector has a low flow switch associated with it which starts the stand-by fan on a low flow signal. This signal is discussed later in the Controls section of this text. The display for this flow sensor is located on the HVAC Control Panel. The detector also has a high and low flow alarms which can be adjusted using contacts on the indication.

The second flow sensor is part of the Stack Air Activity Monitoring System (SAAM). It is a hot wire anemometer. A hot wire anemometer measures flow by electrically heating a wire and measuring the heat removed by the air stream. This detector is used in the sampling process to control flow in the sample system, but it also sends its flow signal to the DCS, and the DCS has high and low flow alarms for the Main Exhaust System which are provided by the SAAM System.

Control Room HVAC

The Control Room HVAC System is a self-contained unit, which operates similarly to a conventional air conditioning unit. The operator will have access to the controls of the system. These controls are located on the face of the control unit which is located in the IER. These controls allow for the change of setpoints. Once these setpoints are in place, the system runs automatically.

Summary

Each subsystem of the HVAC System has the controls and instrumentation required to perform it’s function. These instruments include pressure detectors, flow sensors, and temperature detectors.

CONTROLS, INTERLOCKS, AND ALARMS

ELO 3.03	**EXPLAIN** how the following Heating, Ventilation, and Air Conditioning System equipment is controlled in all operating modes or conditions to include control locations (local or Control Room), basic operating principles of control devices, and the effects of each control on the component operation: a. Chilled Water Pumps b. Chiller Unit c. Air Handling Fan d. Chilled Water Flow in the Air Handling Unit e. Steam Flow in the Air Handling Unit f. Air Handling Unit Inlet Damper g. Main Exhaust Fan h. Main Exhaust Fan Inlet Vane Damper i. Main Exhaust Fan Outlet Damper

Controls

No starting or swapping of running HVAC equipment is controlled by DCS. The temperature and flow controls for the systems rely upon either relay and switch controls, or vendor supplied control units. Several of the controls are internal to the HVAC Control Panel (H-261-HVAC-PNL-001) located in the Control Room. The relay driven controls are mostly contained within the Motor Control Center enclosures, and have wired connections to local switches for starting and stopping.

Chilled Water System

The operator controls for the Chiller Unit are located on the microprocessor control. The controls provided on this system are:

- A multi-step controller which cycles the compressors.
- A five-minute lockout timer which prevents the compressors from short cycling.
- A pump down timer to shut the chilled water pump down on low water flow or high evaporator refrigerant pressure.
- A thermostat to limit compressor loading on high return water temperature.
- A low ambient temperature control consisting of an external damper assembly that controls head pressure for operating down to zero.
- A hot gas bypass sized to minimize compressor loading.

This microprocessor control is equipped with a four-digit display which can be used to access certain information about the system. Some of the information that can be displayed is:

- Return chilled water temperature.
- Effluent chilled water temperature.
- Low effluent water temperature cutout setting.
- Chilled water setpoint.
- Low ambient temperature cutout setting.
- Outside air temperature.
- System 1 and 2 percent full load motor current.
- Suction pressure, oil pressure, discharge pressure, suction pressure cutout setting.
- Eight (8) water cooling range temperature codes.
- Eleven (11) unit fault codes.
- Three (3) possible system 1 and 2 ten-minute anti-recycle status conditions.

The two chilled water circulation pumps are equipped with local manual hand switches. These switches allow for a selection between "OFF", “MAN”, and "AUTO.” A local push-button is provided to "START" the pump.

Air Handling System

The Air Handling System is provided with a local "START/STOP" push-button station located at the air handling unit. This push-button station provides the ability to start and stop the Air Handling Fan. The control relays associated with this LVP controller also provide for some interlocking actions. Relay contacts 42 and 52 are generated from the Main Exhaust System fans. The Air Handling fan can not be started without at least one Main Exhaust System fan running, and will shut down if both fans stop. The PLC interlock is normally closed, but will open and secure the fan if a fire is detected in the Incinerator/Ashcrete Area (Zone 3) or if smoke is detected in the Air Handling duct (Zone 32). When the fan is started, the solenoid is energized to admit air to open the inlet damper for the unit.

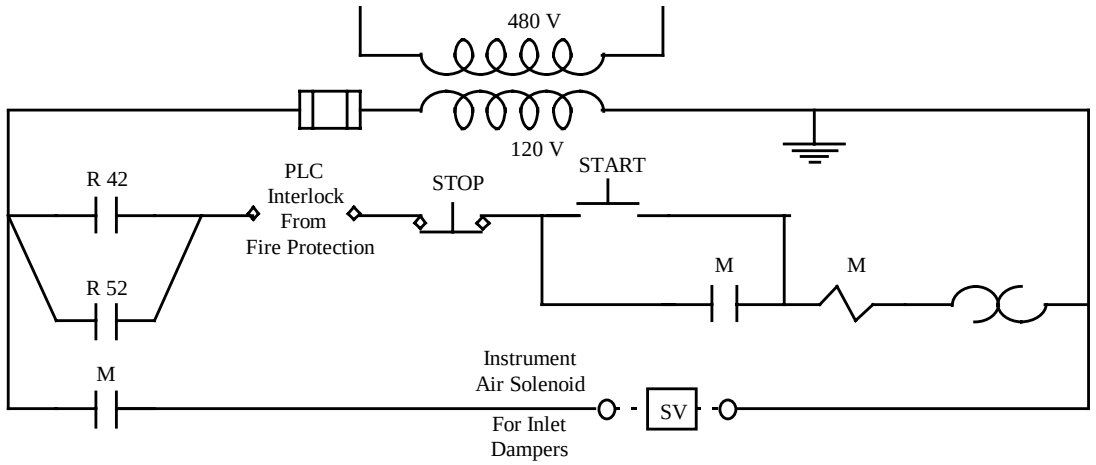

Figure 8 Air Handling Fan Control Circuit

A temperature element (H-261-HVAC-TE-5116) is located in the Air Handling System duct after the Air Handling Fan. This element and its associated transmitter (H-261-HVAC-TT-5116) send temperature information to the HVAC Control Panel. The air temperature in the duct is displayed on an indicator (H-261-HVAC-TI-5116) and used in the system to regulate water or steam flow as required by the thermal load. The temperature controller for the outlet air temperature is set at 56°F for the cooling water and 49°F for steam

Main Exhaust System

The Main Exhaust System maintains the three (3) enclosures (Ashout, Kiln Feed and Box Handling) at a negative pressure relative to the atmosphere by pulling a draft stronger than the air is being supplied by the air handling unit.

Certain controls for the Main Exhaust System are located on the HVAC Control Panel located in the ICR. This control panel is not to be confused with the control panel for the Control Room HVAC System. Controls for the exhaust fans are local hand switches with two-position selection - OFF and AUTO. A "START" push-button is also provided to manually start the fans locally.

The system is equipped with isolation and control dampers. Isolation dampers provide the ability to isolate equipment for repairs or for standby situations. Control dampers are utilized to control the air flow through the system. Certain dampers are manually controlled, while the inlet and outlet dampers of the fans are automatically controlled.

The centrifugal fans are supplied with variable inlet vane dampers. The vane dampers are controlled by a pressure controller (H-261-ME-PIC-2003), which senses the vacuum at the inlet to the main HEPA Filters. The vacuum in the system is developed by the operating Main Exhaust Fan. As the HEPA filters operate, a greater drop in pressure across the filters results in a lower vacuum at the inlet, sending a signal for the vanes to open. This action will increase the flow through the system.

The outlet damper of the fan is configured to shut when the fan is off to prevent back flow through the fan. This is accomplished using solenoids powered from the control relays. The dampers require air to open, so with the solenoid not energized, the outlet damper will be closed.

The system utilizes a low-flow switch (H-261-ME-FSL-2005) which receives the flow signal from the flow element (H-261-ME-FT-2005) to detect the need for the standby fan to start. The flow switch closes a contact in the motor control circuitry for the Main Exhaust fans. This contact energizes the low flow relay (R-61) which closes contacts in the fan relay circuit path. If the running fan does not provide sufficient flow to keep the low flow switch open, the stand-by fan will start. The circuit for the running fan must also be made, or the electric signal path through contact 42 or 52 will not exist.

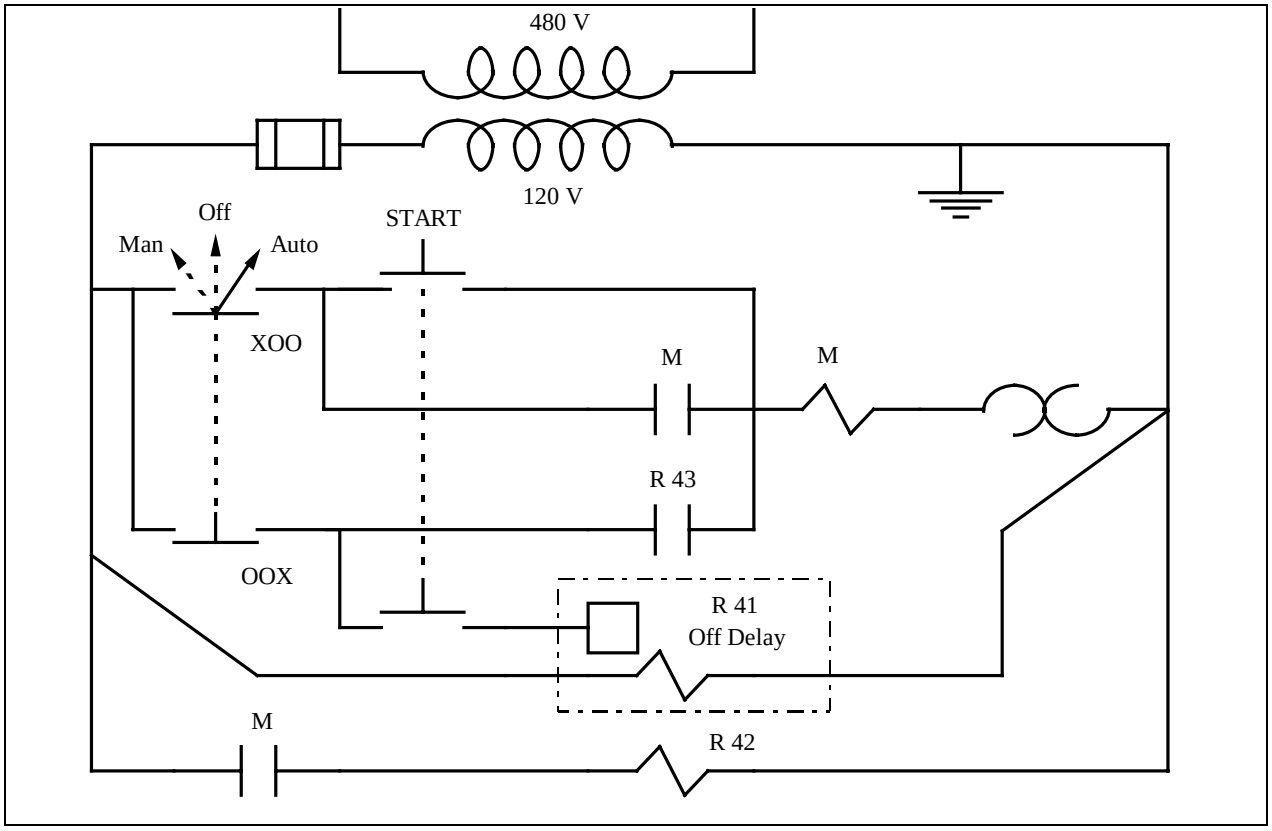

Figure 9 Main Exhaust Fan #1 Motor Control Relays

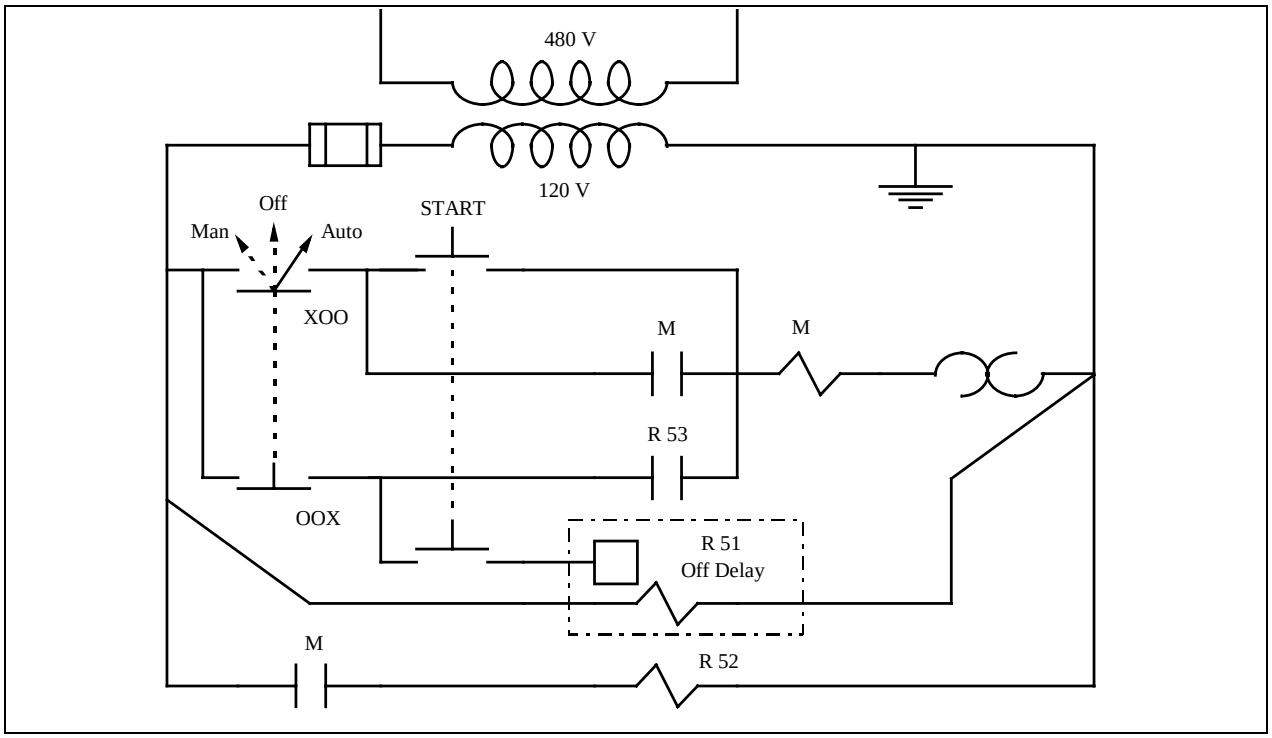

Figure 10 Main Exhaust Fan #2 Motor Control Relays

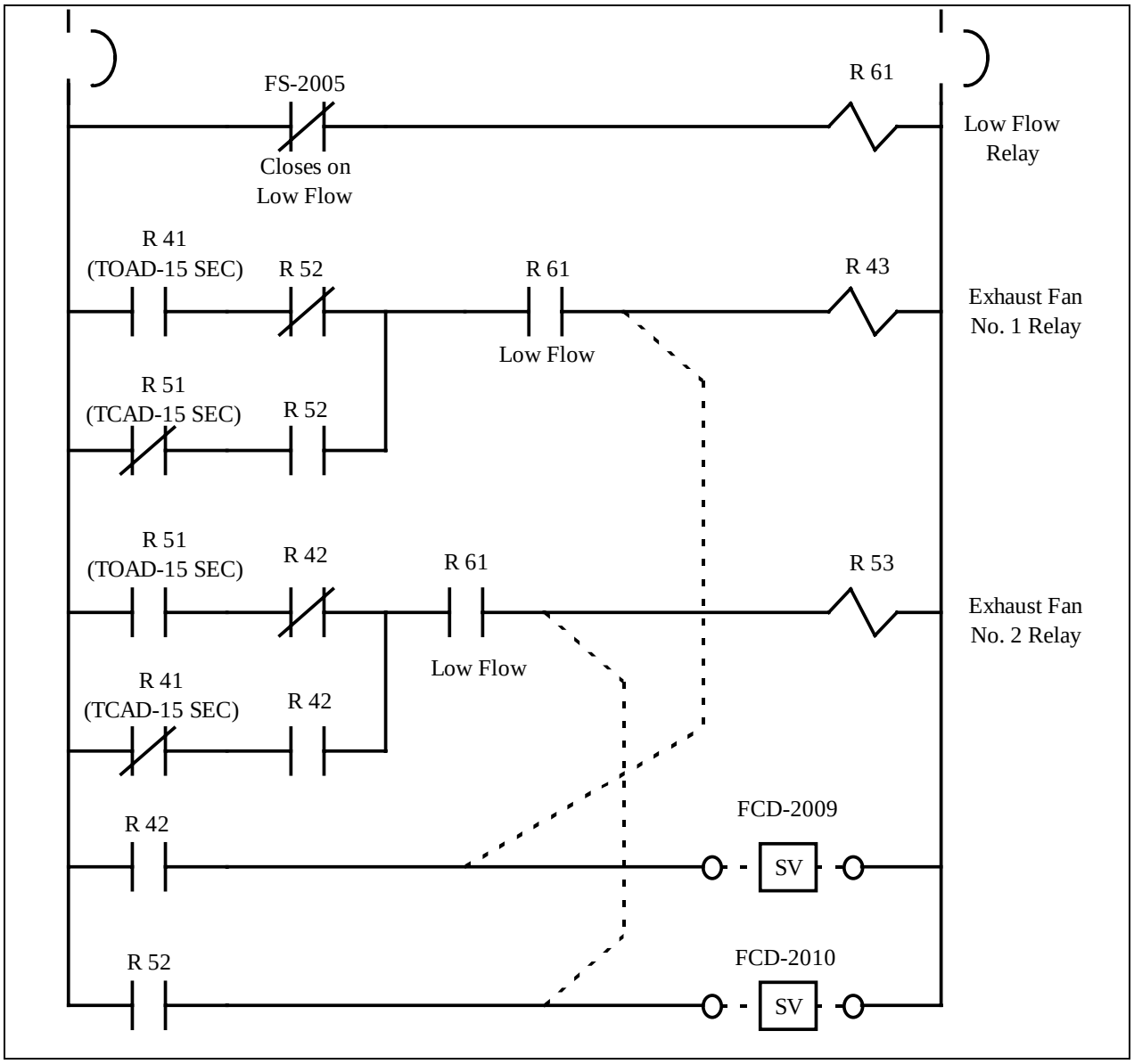

Figure 11 Main Exhaust System Fan Control Relays

Control Room HVAC System

The Control Room HVAC System is a pre-packaged, self-contained system that is supplied with a microprocessor-based control system. The system is provided with two LED numerical displays which allow observation of room temperature and humidity. Normal Operating Modes (Heating, Cooling, Humidification, Dehumidification) are indicated by colored LEDs on the unit-mounted display panel. The functions which may be set are listed in Table 1, *Control Room HVAC Controls.*

Control	Setpoint
Temperature Setpoint	65° to 85°F
Temperature Sensitivity	±1° to ±5°F
Humidity Setpoint	40% to 60% R.H.
Humidity Sensitivity	±1% to ±10% R.H.

Table 1 Control Room HVAC Controls

Interlocks

ELO 3.04 **DESCRIBE** the interlocks associated with the following Heating, Ventilation, and Air Conditioning System equipment to include the interlock actuating conditions, effects of interlock actuation, and the reason the interlock is necessary:

a. Main Exhaust Fan

b. Air Handling Fan

c. Control Room HVAC

d. Toilet Exhaust Fan

The interlocks for the HVAC system are relay and contact generated. Except for the PLC contact in the Air Handling Fan motor control circuit, and the flow sensors in the Main Exhaust System duct from the kiln seal shroud, no DCS interaction takes place.

Chilled Water System

Once started, the Chilled Water System is designed to operate automatically. The system will shut down under certain conditions:

- Low chilled water temperature
- High discharge temperature for each compressor
- Low suction pressure for each compressor
- Low oil pressure
- Low flow in chilled water line (H-261-CHW-FSL-2008)

These automatic controls are designed to prevent operation of the system in conditions which could lead to equipment damage, since a failure of the Chilled Water System will not require immediate shutdown of the entire HVAC System.

Air Handling System

The system contains a PLC contact which is controlled by signals from the Fire Protection/Fire Detection and Alarm System. This PLC contact must remain closed to start or continue to run the Air Handling Fan. If smoke is detected in the inlet to the Air Handling Unit (Main Fire Alarm Control Panel Zone 32), or a fire is detected in the Incinerator or Ashcrete Areas(Main Fire Alarm Control Panel Zone 3), the PLC contact will open and the fan will shut down.

The air handling fan also interlocks with the Main Exhaust System to shut down the air handling fan if both exhaust fans fail. This interlock is necessary to eliminate the possibility of pressurization in the supplied compartments.

Main Exhaust System

If the HVAC is lost to kiln seal shroud enclosure, as measured by ME-FT-1719 or ME-FT-1719, the detector will send a low flow signal to DCS. This signal interlocks within the BMS to secure waste feed. This interlock ensures that any flow from the rotary kiln seal shroud is filtered and exhausted by the building exhaust.

ELO 3.05	**INTERPRET** the following Heating, Ventilation, and Air Conditioning System alarms, including the conditions causing alarm actuation and the basis for the alarms: a. HEPA Filter differential pressure b. Main Exhaust Flow c. Chiller Failure

Alarms

No alarms exist which are associated with the Air Handling System. The Chilled Water System has a single remote alarm, the Chiller Failure, which sounds on the HVAC Control Panel. The Main Exhaust System has alarms for high and low flow.

Chilled Water System

The Chiller Failure alarm is sounded when the chiller unit is automatically shut down. Since several conditions can cause chiller shut down, the operator must access the local panel on the chiller unit to determine the cause of shut down.

Main Exhaust System

The Main Exhaust System maintains the three (3) enclosures (Ashout, Kiln Feed and Box Handling) at a negative pressure relative to the atmosphere by pulling a draft stronger than the air is being supplied by the air handling unit. Differential pressure transmitters are supplied on the HEPA filters to alarm on a high signal. Also, an alarm input to DCS is provided for a low flow and low low flow from the kiln seal shroud. The alarm setpoints associated with the Main Exhaust System can be seen in Table 2, *HVAC Alarms.*

Alarm	Setpoint	Unit
HEPA Filter Differential Pressure ME-PS-2004	5.0	ΔP INWC
Kiln Seal Shroud Air Flow Low ME-FSL-1718 & 1719	1000	LB/HR
Kiln Seal Shroud Air Flow Low Low ME-FSLL-1718 & 1719	950	LB/HR
Main Exhaust Low Flow to Stack ME-FS-2005	15,000	CFM

Table 2 Main Exhaust Alarms

Control Room HVAC

The control system monitors unit operation and activates an audible and visual alarm in the event of certain conditions. The following are the factory pre-set alarm conditions:

Summary

- The HVAC system is provided with automatic features which allow the operator to maintain the system in operation with little or no intervention once the system is started.
- Automatic functions shut down the air handling fan on Main Fire Alarm Control Panel Zone 3 or 32, or if both main exhaust fans are stopped.
- Low flow from the kiln seal shroud will shut down waste feed to the incinerator.

SYSTEM INTERRELATIONS

Service Water System

If the water pressure in the Chilled Water System falls below 20 psig, the system will allow an addition of makeup water supplied from the service water system.

Low Pressure Steam

The Air Handling System receives steam for the heating coil from the low pressure steam header. Low-pressure steam also supplies the five unit heaters located in the Box Handling Area.

Kiln Seal Shroud

The kiln seal shroud exhaust air flows from the shroud and is filtered through a HEPA filter prior to entering the main duct work of the Main Exhaust System.

Air System

The Instrument Air System supplies the Air Handling System and the Main Exhaust System with motive force to operate automatic dampers. The Instrument Air System also provides controlling and operating force for the cooling coil and steam inlet control valves.

Fire Protection/Fire Detection and Alarm

The Fire Protection/Fire Detection and Alarm System is hardwired to the Air Handling System to secure the air handling fan if a fire is detected in the Box Handling Area or the Incinerator Area. The Fire Protection/Fire Detection and Alarm System secures the Control Room HVAC unit if a fire is detected in the ICR or IER.

INTEGRATED PLANT OPERATIONS

ELO 4.01	**STATE** the personnel safety concerns associated with the Heating, Ventilation, and Air Conditioning System.

Safety

The steam lines of the Air Handling System may be hot at times. Proper protective clothing should be worn when operating steam line valves or working around steam lines. Operators should take caution around any steam leak. Steam line safety should also include precautions and practices to avoid water hammer. The chiller units use freon as a refrigerant. Personnel should be aware that Freon is a hazardous material, and the applicable controls must be used. The operators should follow all safety requirements prescribed by the 8Q, 4Q and 4Q1.6 Manuals.

Normal Operations

ELO 4.02	Given applicable procedures and plant conditions, **DETERMINE** the actions necessary to perform the following Heating, Ventilation, and Air Conditioning System operations: a. Startup b. Manual Operation of Equipment c. Shutdown

Normal operation of the HVAC System is important to the successful operation of the CIF since much of the heat generated by the kiln in the enclosures is removed by this system. Also, the HVAC System is important in maintaining positive pressure of the Control Room and negative pressure of process areas to protect the operators and environment in the event of system boundary failure.

Chilled Water System

The Chilled Water System will be aligned and operated per procedure 261-SOP-CHW-01. The alignment includes valve positions and breaker positions of the Chilled Water System. Once all system alignments and pre-start checklists have been completed, the Chilled Water System is ready for startup.

The startup of the Chilled Water System involves filling, pressurizing and initiating circulation of the chilled water lines of the system. The process includes such items as attaching leak collection systems, throttling valves for proper flow, and starting the chilled water pumps for circulation of the water.

Air Handling System

The Air Handling System will be aligned and operated per procedure 261-SOP-HVAC-01. Alignment of the system involves positioning of valves, dampers and breakers. The startup and shutdown of the Air Handling System are performed by starting or stopping the air handler fan utilizing the local "START/STOP" push-button station.

The steam lines will also be operated per procedure 261-SOP-HVAC-01. Startup of the steam lines involves a warm-up process outlined by the procedure. This process is necessary to clear the lines of condensate to reduce the possibility of damage to the equipment and protection of personnel.

Main Exhaust System

The alignment of the Main Exhaust System consists of aligning the valves, dampers, breakers, hand switches, and the DCS per procedure 261-SOP-ME-01. For startup of the exhaust system, one fan will be placed in operation and the other fan will be placed in standby. The fan will be started by pushing the local START push button. The other fan will be placed in standby by positioning the local Manual-Off-Auto (MOA) switch to “AUTO.” Prior to placing a HEPA filter on service, a DOP test must have been performed to verify the integrity of the filter enclosure. Two filters will normally be in service. Following startup, an inspection will be made by the operators to ensure proper operation of the Main Exhaust System.

If the Main Exhaust System is to be shut down, the first operator action will be to secure the standby exhaust fan. Once the standby is secured, the operational fan can be stopped. Shutting the Main Exhaust System down will cause an automatic shutdown of the air handling system fan.

Control Room HVAC

The Control Room HVAC System operates similarly to any conventional residential HVAC System. This system, however, does allow for humidity control of the Control Room . The controls of the system allow for changes in setpoints. Once the setpoints are established, the system is automatically controlled.

Abnormal Operations

ELO 4.03	**DETERMINE** the effects on the Heating, Ventilation, and Air Conditioning System and the integrated plant response when given any of the following: a. Indications/alarms b. Malfunctions/failure of components c. Operator Actions

Chilled Water System

Abnormal events for the Chilled Water System would include the failure of such components as pumps, compressors, and valves or conditions such as breaks, plugging or leaks. A failure or condition should initiate an operator response for recovery of the chilled water. A "CHILLER FAILURE ALARM" should signal the operator to reference the Chiller Control Panel to determine the cause.

If the Chilled Water System fails, the area (supplied by the air handler) temperatures should be monitored. If the cause of failure cannot be determined or corrected by the facility personnel, then the facility should be shut down from normal operations to warm standby if conditions require.

Air Handling System

Abnormal events for the Air Handling System would include the failure of such components as local air monitors, dampers, centrifugal fan, filters (plugging) and building supply fans. Pressure sensors in the Ashout, Kiln Feed and Box Handling Areas will signal an alarm to notify the operator of an air flow problem. These problems should prompt the operators to take corrective action by confirming the symptom and correcting the problem. If the cause of failure cannot be determined or corrected by the facility personnel, then the facility should be shut down from normal operations to warm standby.

The Air Handling System will automatically trip off if both exhaust fans are lost or if a fire is detected in either the Box Handling Area or the Kiln Feed Area. Again, if the cause of failure cannot be determined or corrected by the facility personnel, then the facility should be shut down from normal operations to warm standby.

Main Exhaust System

Abnormal events for the Main Exhaust System would include the failure of such components as the HEPA filters, dampers, damper positioners, exhaust fans, system pressure controller and pressure sensors. A component failure should prompt the operators to take corrective action.

Component failures could result in an alarm condition. If an "EXHAUST AIR TO STACK FLOW ALARM" exists, the operator should confirm the symptom and attempt a recovery. Now, if area pressures are high, all solid and liquid waste should be stopped and a recovery attempt made. If recovery is not possible, the facility should be shut down from normal operations to warm standby. If a differential pressure alarm signals for the HEPA filters, the standby filter should be utilized to change out the fouled filter housing.

An automatic action of the system involves the two exhaust fans. In normal operation, one fan is in use while the other is in standby. In the event that the operational fan is lost and the standby fan fails to energize, then the system signals the Air Handler fan to shut down. This action eliminates the possibility of an enclosure pressurization.

Control Room HVAC

A roof exhaust fan is provided to purge air to the atmosphere from the restrooms of the Control Room . If a signal is received from the DCS that a building radiation monitor has been activated, this roof exhaust will be automatically shut down.

Summary

- Failure of components in the HVAC System could remove the ability to cool the Box Handling, Kiln Feed, and Ashcrete Areas.
- Based upon outside air temperatures, this may result in manual shutdown to Warm Standby to protect operators and heat-sensitive PLC/DCS components.
- Loss of the Main Exhaust System will require shutdown to warm standby to prevent the release of unfiltered exhaust.